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DIFFERENTIAL CODABILITY OF STIMULUS ATTRIBUTES.

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THREE PREDICTIONS DERIVED FROM THE NOTION OF THE DIFFERENTIAL CODABILITY OF STIMULUS ATTRIBUTES WERE TESTED. THE STIMULI WERE 24 MUNSELL COLOR CHIPS, VARYING SYSTEMATICALLY IN BOTH HUE AND VALUE. EACH OF 16 SS (SUBJECTS) IN GROUP I SORTED THE CHIPS INTO HOMOGENEOUS GROUPS, WROTE A VERBAL DESCRIPTION OF EACH COLOR, IDENTIFIED HUES ONLY AND VALUES ONLY, AND IDENTIFIED BOTH HUES AND VALUES OF EACH COLOR. SIXTEEN GROUP II SS USED THE MESSAGES OF THE GROUP I SS TO FIND THE COLORS DESCRIBED THEREIN. THERE WERE SIGNIFICANTLY MORE ERRORS IN COMMUNICATING VALUES THAN HUES, THE PREFERRED BASIS FOR SORTING WAS HUE, AND THE PRESENCE OF A DESCRIMINABLE HUE INTERFERED WITH NAMING THE VALUE OF A COLOR IN THE SINGLE RESPONSE TASKS BUT NOT IN THE DOUBLE RESPONSE TASKS. THE IMPLICATIONS OF THE EXPERIMENTS FOR FUTURE STUDIES OF CODABILITY, RECALL, PROBLEM-SOLVING, AND LINGUISTIC RELATIVITY WERE DISCUSSED. THIS REPORT APPEARS IN "STUDIES IN LANGUAGE AND LANGUAGE BEHAVIOR, PROGRESS REPORT V," SEPTEMBER 1, 1967. (AUTHOR/AMM)

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Differential Codability of Stimulus Attributes[1]

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3 predictions derived from the notion of the differential codability of stimulus attributes were tested. The stimuli were 24 Munsell color chips, varying systematically in both hue and value. Each of 16 Ss in Group I sorted the chips into homogeneous groups, wrote a verbal description of each color, identified hues only and values only, and identified both hues and values of each color. 16 Group II Ss used the messages of the Group I Ss to find the colors described therein. There were significantly more errors in communicating values than hues; the preferred basis for sorting was hue; the presence of a discriminable hue interfered with naming the value of a color in the single response tasks but not in the double response tasks. The implications of the experiments for future studies of codability, recall, problem-solving and linguistic relativity were discussed.

Several experiments have shown that Ss, when faced with a complex stimulus array, tend to base their responses on subsets of attributes (e.g., Underwood, Ham, & Eckstrand, 1962; Berelson, Lazarsfeld, & McPhee, 1954) rather than on the full panoply of cues which are objectively present. There may be three different bases for this selective attention to aspects of the environment: (a) internal motivational states, including species-specific reactions; (b) experimental conditions; and (c) socio-cultural learning, including one's native language. Since most cognitive activities probably include some kind of verbalization, it may well be that the "high-priority" attributes of a given complex stimulus are also more codable, in the "communication" sense of the concept (Lantz & Stefflre, 1964). It has been argued (Brown, 1958) that the codability of an attribute is positively related to the ease and frequency with which it will be used in cognitive activities, but this point has not been tested experimentally.

Previous studies of the codability of complex stimuli (Van de Geer & Frijda, 1961; Koen, 1966) have dealt with each item as a unit, and have not investigated the possibility that attributes of the same stimulus may be differentially codable. It has been shown that the codability of stimulus items is related to recognition after short intervals (Lantz & Stefflre, 1964; Koen, 1966) and that the ready availability of appropriate verbal labels facilitates some kinds of problem-solving (Glucksberg & Weisberg, 1966). If it can be established that

the component attributes of a complex stimulus are indeed differentially codable, this finding would have important implications for cognitive activities involving those attributes. For example, there may be a tendency to prefer the more codable, more salient dimensions as bases for the categorization and subsequent processing of incoming stimuli. Thus we could make predictions about attention, learning, recall, concept formation and other cognitive processes on the basis of codability data.

One class of stimuli to which human beings customarily give high priority are the elements of their native language. In the presence of complex stimuli, including both verbal and non-verbal components, subjects' behavior shows a strong tendency to be controlled by the former. Jensen and Rohwer (1966), in a review of experiments using the Stroop color-word test, report that it is much easier for Ss to call out a word than the color of the ink in which it is printed when the two are incongruent (e.g., the word blue in red ink). Klein (1964) attempted to account for this effect in terms of the "attensive power" of the word, and found a positive relation between the relevance of lexical items to the experimental situation and interference in naming ink colors. For example, the average time for naming the ink colors (red, green, yellow and blue) of 100 groups of asterisks was about 44 sec.; for nonsense syllables (e.g., evgjc), 50 sec.; for words that imply colors (e.g., grass), 59 sec.; and for incongruent combinations of word and color (e.g., yellow in green ink), 81 sec. Klein argued that since the vocal channel can handle only one response at a time, the closer the motor component of the word's meaning comes to the color-naming response, the greater the interference. In the face of such response competition, the effort to inhibit the near-threshold word-meaning response may account for the delay. If this is indeed the case, Klein reasoned the delay should be much less if the subject is allowed to "get the word out his system" before calling out the ink color as compared with the time required to perform both tasks in reverse order (color-then-word). A second experiment confirmed this prediction. Klein then suggested that this procedure provides a way of measuring the "semantic power" of words.

If there is an association between the codability of attributes and a differential disposition to respond to real world stimuli in terms of those attributes, as suggested by Brown (1958), and if, as seems likely, the words used in Klein's experiments were both more salient and more codable than the ink colors, the interference found may be subsumable under the concept of the differential

codability of stimulus attributes. The interference, rather than stemming solely from response competition, may also reflect the Ss' difficulty in breaking their overlearned habits of selecting and internally representing certain aspects of a situation in preference to others. If this is indeed the case, Klein's results may have implications far beyond those associated with the "semantic power" of words, and may be generalized to virtually any multi-dimensional stimulus. It should be possible, then, to predict the relative response times of Ss to individual attributes and to their combinations, even though none of the attributes is symbolic in character. This proposition can be studied with a set of stimuli in which at least two dimensions can be independently specified and systematically varied, such as the Munsell color array.

If the color, hue and value, attributes are differentially codable, the following predictions can be made: (a) in a sorting task, Ss will prefer the more codable dimension as a basis for the categorization of colors; (b) when color stimuli have identifiable positions on both hue and value continua, the time required to name the high codable attribute alone will be significantly less than that required to name the low codable one; and (c) the time required to name both attributes in the order high codable-low codable will be significantly less than in the order low codable-high codable.

Method

Subjects. There were 16 Ss each in Groups I and II. All were paid volunteer undergraduates at the University of Michigan. There were eight males and eight females in each group.

Stimuli. The principal stimuli were 24 3/4 in. square Munsell color chips consisting of the hues 7.5 Y, 5 RP, 10 BG, 7.5 YR, 2.5 PB, and 5 G, and the values 8, 6, 5, and 3 in each hue. Chroma varied unsystematically, being the highest chroma obtainable for each hue-value combination. There were two identical sets of 24 3 x 5 cards, each with one chip attached. In addition, the following "arrays" were constructed, each array consisting of a 4 x 6 matrix of chips on a 9 x 11 in. poster board: (a) a "random array" of the experimental stimuli arranged in a single random order; (b) a "hue only" (Ho) array of four replications of each of the six hues, all at value number 6; (c) a "value only" (Vo) array of six replications of each of four pure gray chips, values 8, 6, 5, and 3; (d) a "systematic array" of the experimental chips with all chips of the same hue in a single column, and all chips of the same value in a single

row; and (e) two arrays, each consisting of two replications of 12 of the experimental chips, constructed individually for each S.

Apparatus. The A-O, H-R-R Pseudoisochromatic Plates, 1957 Edition, were used to test Ss' color-vision. Illumination was by fluorescent light and was constant for all Ss and all tasks. All experimental sessions were tape-recorded, and timing was by stopwatch.

Procedure. Each S in Group I served in 12 different conditions. The first four tasks were in the same order for all Ss, but the order of the last eight was systematically balanced, with each S receiving a different order. The first four tasks were untimed. Task 1 was color-vision screening--one S was dismissed because of defective color perception. In Task 2, the S was given a set of 3 x 5 cards, each with a single chip on it, and told to sort them into "as many piles as you wish, on any basis you choose, so that each pile will contain colors which are alike in some particular way." When he had completed the sorting task, he was asked what his classification basis was, and a record was made of all the chips which were included in each of his categories. Then the S was given the other set of 3 x 5 cards and asked to sort them a second time, but "on some basis other than the one you just used," with the same kinds of records being taken. Task 3 called for the S to write out a description of each color "so somebody else could find that chip in the random array entirely on the basis of your description." The random array was in full view of the S while he was engaged in this task. In Task 4, the S was asked to choose a single-word name for each hue which he would be willing to apply to all four of the values in which the hue occurred, and he was tested for consistency of use. Then, since the highly overlearned language habits of native English speakers could introduce a systematic bias to the task of naming both hues and values (in both orders), S was taught to label the values "1, 2, 3, and 4" from light to dark. He was then tested for his ability to use the substitute code accurately. The systematic array was used for this task. An additional effect of repeated exposures of the S to the experimental stimuli was familiarization. It was desirable to reduce problems of perceptual discriminability in the later phases of the experiment to a minimum.

At this point, the S was sent out of the room while the average number of words used to describe each hue was calculated and two arrays were constructed, one consisting of chips of the three hues which elicited the shortest average

descriptions, and the other made up of hues with the highest averages. These arrangements usually required about 15 min. Earlier studies (Brown & Lenneberg, 1954; Glanzer & Clark, 1963) have found that in certain circumstances length of description is related to accuracy of later recognition. In this experiment, although S's overt identification of each chip was restricted by instructions to two words (a number and a color name), it was possible that the time required for covert cognitive processes might reflect the length of the S's spontaneous verbal descriptions. Knowledge of the number of words in the descriptions thus might help explain differences in response time, the principal dependent variable.

Upon his return to the experimental room, S was reviewed on his ability to use his hue names and the number code for values accurately and consistently, using the random array. The remaining tasks were all timed. Tasks Ho and Hr called for naming the hues in the "hue only" and random arrays respectively and were always juxtaposed as a pair. Similarly, tasks Vo and Vr constituted another pair and required naming the values in the "value only" and random arrays. These four were single-response talks, calling for the identification of either hues or values. The remaining tasks are labelled H/V (identification of both hue and value in that order, using the S's "short description" array); h/v, identification of hue and value, using the S's "long description" array; V/H, identification of both attributes, from the short description array; and v/h, identification of value and hue with the long description array.

Each S first performed the single response task-pairs Ho and Hr, or Vo and Vr (with order within pairs balanced). The next four tasks called for double responses-naming both hues and values. Tasks H/V and h/v formed an interchangeable pair, as did V/H and v/h. Eight different orders of these four tasks were used twice each, with order within pairs and between pairs balanced. The last two tasks again called for single responses, being either Vo and Vr or Ho and Hr, depending on the earlier single response pair; again within-pair orders were balanced.

All identification tasks were carried out under instructions to "be as fast and as accurate as you can." The time in seconds and the number of errors were recorded for each task. Group II Ss decoded the descriptions of the color chips which had been written by Group I Ss, by identifying the color chip to which each referred. Each Group II S decoded 24 descriptions, one from each of eight

Group I Ss, and two from the remaining eight. In this way, all descriptions were decoded once. Group II Ss operated under instructions to "find the color chip to which each description refers." The task was not timed.

Results

Total response time and number of errors were recorded for each S on each task. However, the two measures are so highly correlated (positively) that results will be reported only in terms of total time. Differences in response time associated with the length-of-description variable were negligible; H/V and h/v data were therefore pooled and will be reported as H/V, and V/H and v/h data as V/H.

The first prediction suggested that the preferred basis for the classification of color stimuli will be that dimension (hue or value) which can be shown to be more codable. According to the communication accuracy definition of codability (Lantz & Stefflre, 1964) those stimuli are most codable which are communicated most accurately between Ss by verbal means. The relative codability of the two attributes was determined by comparing the number of errors in the transmission of hue and value information from Group I encoders to Group II decoders. An error was scored as the choice by a Group II S of a color chip other than the one which was originally described by a Group I S; errors, of course, could occur on either or both dimensions. Comparisons were made by t-test for correlated data. The mean number of hue errors per color was 1.67; value errors, 4.83. The difference is highly significant ($t=4.28$, $df=23$, $p < .001$, 2 tails), and hue is clearly the more codable attribute in this array. The second task of the Group I Ss consisted of two separate sortings of the 24 color chips into an unspecified number of homogeneous groups. The first sorting of all 16 Ss was based on the hue dimension; the second sorting of 13 Ss was based on the value dimension. The other three Ss again sorted by hue by redefining the categories (e.g., by combining G with Y rather than with BG). We may conclude that hue is the more codable attribute and is the preferred basis for categorizing behavior.

Because it would be instructive to identify possible practice and order effects, and their interaction in the single and double response tasks, the data for Group I Ss were divided into two sub-groups and analyzed separately, as well as together. Group IA Ss had performed the H/V double response task first, and then the V/H task; Group IB Ss were those who had performed these tasks in the reverse order.

The second prediction said that when a S was presented with an array varying in both attributes, and was required to identify either the hue or the value of each chip, the total response time for naming the more codable attribute (i.e., hue) would be less than that for naming values. This question can be tested by comparing Hr and Vr times. Table 1 presents the mean response times for all single response tasks. The mean Hr time of 29.2 sec. is significantly less than

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Insert Table 1 about here

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the mean Vr time of 48.3 sec. ($t = 6.01$, $df = 15$, $p < .001$, 1 tail), supporting the second prediction. It is not likely that this result can be explained by the relative perceptual discriminability of hues and values. The Ho and Vo times in the table provide rough estimates of relative discriminability, since in both these cases the arrays varied in only the one dimension. It will be noted that Ho and Vo times are virtually equal for Group IA, but the (Vr - Hr) difference is significant at the .02 point ($t = 2.64$, $df = 7$, 1 tail). Furthermore, since hue is the more codable attribute, there is a tendency to encode it first. Therefore, the "interference" in the Vr single response task which may be attributed to hue is indicated by the (Vr - Vo) difference. Similarly, the interference of value in hue-naming (Hr) may be estimated from the (Hr - Ho) difference. Comparing the two differences (19.7 and 7.6 sec. respectively) provides another index of the relative interference associated with the differential codability of attributes. A t-test for correlated data proved highly significant ($t = 4.20$, $df = 15$, $p < .01$, 2 tails). It does appear to take longer to name a relatively low codable attribute in the presence of discriminable values of an attribute of high codability.

The differences between Groups IA and IB in the value-naming tasks (Vo and Vr) were unexpected. In both tasks, Group B Ss required significantly longer times for value-naming. In an attempt to explain these results, the following parameters of the experimental situation were examined for possible systematic effects on the data: (a) sex distribution of the sub-groups; (b) order of tasks within pairs; (c) order of single-response task-pairs (before or after the double-response tasks); (d) order in which Ss in the two groups were run; and (e) extreme scores by a few individuals. There were no substantial differences between the groups on any of these factors. The environment was constant throughout the study, including experimenter, lighting, stimuli, apparatus and experimental

space, and the highly significant difference on these tasks remains unexplained. Fortunately, these differences do not change the overall results of the study nor lead to different conclusions.

The third prediction dealt with the order in which the attributes were named in the double-response tasks--it was anticipated that the H/V tasks would require less time than the V/H tasks. Table 2 presents the naming times for the double response tasks. If there is a tendency to encode hue (the high codable attribute) first, there should be interference, and lengthened response times, in the V/H condition, but little or none in the H/V condition. It can be seen from Table 2 that the prediction was not supported. The obtained dif-

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Insert Table 2 about here

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ferences in time between Groups A and B can be almost completely explained by the average 13.1 sec. difference in value-naming times (see Table 1). A repeated measure analysis of variance showed practice effects that were marginally significant at the .05 level. It is interesting to note that these effects were apparently due almost entirely to increased facilitation in <u>combining</u> the two encodings rather than in the faster identification of individual attributes. This is shown by the fact that the average Ho, Vo, Hr and Vr times were very consistent, regardless of whether they were obtained before or after the double response tasks.

It was thought that perhaps the device of recoding the values with numbers was unsuccessful in its attempt to avoid the possible biasing effects of English word order. If syntactic habits require that the order V/H be operative, it would tend to negate the effects believed to be associated with the differential codability of attributes. To investigate this possibility, six additional <u>Ss</u> were run with all conditions exactly the same as for Group I <u>Ss</u>, except that each <u>S</u> chose his own ordinary English name for the values, just as he did for the hues. If word order were an important factor, this should create considerable interference in the H/V condition and facilitate the V/H condition. It did not. The average times on all tasks, both single and double response, were remarkably similar to those for Group I.

Discussion

It was suggested earlier that Klein's (1964) results might profitably be interpreted in terms of codability. However, the present experiment failed to replicate his results in the double response task. An explanation may lie in the relative familiarity of the stimulus situations facing the Ss in the two studies. The necessity for attending to the color of the ink in which a word is printed is an unusual one in the ordinary course of events; the "registering" of both the hue and value of a color is surely quite familiar. A recent study by Lindsay and Lindsay (1966) suggests that Ss engaged in a recognition task may process familiar stimuli as total patterns--perhaps making use of some sort of template-matching, thus comparing all dimensions simultaneously. However, unfamiliar stimuli seem to be processed by a serial examination of stimulus dimensions.

It appears that hue is the "preferred" attribute upon which we base our responses to colors, though we may well tend to internally represent both hue and value at each presentation of a color stimulus. If this is the case, the following may provide an adequate explanation of the results of the single and double response tasks calling for value identifications: Ss applied a hue-value template to the stimulus, and then deleted the hue element from the verbal report in the Vr condition. This suggestion is supported by the fact that response times to values alone in the Vr situation were as long as the practiced double-response times, as can be seen by comparing the data in Tables 1 and 2. For Group IA, average Vr time is 41.0 sec., and V/H time, 45.6; for Group IB, the comparable times are 55.7 for Vr and 55.6 for H/V. In the double-response task, S could analyze the two attributes simultaneously, and report them both, since this is what he was doing anyway, and the order in which he reported them was immaterial.

If the above constitutes a useful analysis of the situation, it leads to two interesting predictions. Differences in double response times could be expected in the following situation involving color stimuli. If the stimuli were the colors orange, purple, and green, and the S was required to identify the hue and the two primaries which produce it, it can be predicted that the order hue-primaries will yield shorter response times than the order primaries-hue. Although all Ss may know the constituent primaries of the three colors, a conscious specification of them is seldom done. A second experiment testing the validity of the speculations above would involve verbal stimuli. No difference

in double-response times would be predicted if Ss were required to identify a word and state whether it was printed in upper or lower case letters. This prediction is based on the assumed congruity of these two aspects of verbal stimuli. It is to be expected that the absolute times for the first experiment would be considerably greater than those for the second, but since Ss would be saying the same words within each experiment--with only the order changed--the difference scores could be compared, in terms of per cent change.

The results obtained in this experiment are quite consonant with those of Morton (1967). In a typical condition, Morton's Ss sorted packs of cards, with one to six repetitions of the symbols 1 to 6 printed on them, into six boxes, depending upon the number of symbols on the card. The dependent variable was time, and Morton's results were much like Klein's in that Ss tended to sort according to the meaning of the symbol (e.g., to place a card containing five 1's in the "1" box rather than in the "5" box). It is highly likely that, had the Ss in the present experiment been required to sort the color chips by values and hues separately, the times for the first task would be significantly greater.

It is suggested that it is possible to view the number of symbols on a card as a low codable attribute of the stimulus facing the S in Morton's experiment, analogous to Klein's ink-colors, and to the values of colors in the present one. Support for this suggestion is to be found in the fact that Morton found less increment in sorting time associated with the words white and black than for the words three, four, etc. It is highly probable that in Klein's experiment the situation would have been reversed, with white and black giving rise to much greater interference. It seems reasonable to view the symbols used in Morton's and Klein's experiments as special cases of high codable attributes, and hence to subsume the results of both earlier studies and the present one under the rubric of differential codability and the behavioral effects associated with the phenomenon.

The results of the present experiment may have implications for the recall of multi-dimensional stimuli. Previous studies (Brown & Lenneberg, 1954; Lantz & Stefflre, 1964; Koen, 1966) indicate that codability is positively related to accuracy of recall, at least for intervals up to 3 min. in length. These observed effects are likely to be more pronounced with longer intervals. The Lantz and Stefflre and Koen experiments both show a clear relation between inter- and intra-individual communication accuracy. That is, those stimuli which are most easily communicated between Ss are those most easily recalled by a given S.

It is assumed that most encoding of real world stimuli involves overt or covert verbalization. Every word which is used in such internal representation carries with it a freight of connotations--often indicated in experimental situations by the word associations elicited by the stimulus word. Therefore, if the features of a complex stimulus which are first encoded are those relatively high in codability, and if encoding is done in verbal terms, it may be possible to predict distortions in the recall of non-verbal events from a knowledge of the word associations produced by the S in response to the label of his high codable attributes. That is, leveling and sharpening effects can be expected to reflect the associative nature of the S's preferred attribute.

In view of the strong positive relation between the codability of an attribute and its apparent availability for cognitive processing (i.e., its use as a basis for the categorization of stimuli), it may be suggested that a knowledge of the relative codability of discriminable features of a complex stimulus allows fruitful predictions of problem-solving and reasoning behavior. There is a considerable literature relating successful problem solution and the availability of relevant verbal cues in the consciousness of the S (Cofer, 1957; Glucksberg & Weisberg, 1966). To the extent that problems are solved in terms which are consonant with those in which they are encoded, it is possible that "errors" may not be the result of poor reasoning, but of inappropriate encoding. This inference is supported by Henle's (1962) data, which indicates that, if Ss' interpretations of syllogisms are accepted, there are few instances of faulty logic in the answers. It may be possible to explain so-called errors in problem-solving tasks through a more exact knowledge of the S's encoding of the situation (i.e., by determining those dimensions to which he has attended and the terms in which he has encoded them). Perhaps improvement in problem-solving can be usefully attacked by viewing it as a matter of translation or encoding strategies.

The idea that is gradually emerging is that codability as a concept is not profitably considered except in conjunction with the stimulus array concurrently presented the Ss. It is apparent that human beings not only select stimuli in the environment to which to respond but that they exert the same selectivity with regard to the constituent attributes of multi-dimensional stimuli. In a given situation, there may well be a preference heirarchy of attributes, which decreases in codability as one moves down the hierarchy. The subset of the hierarchy which is used at any particular time is at least partially a function

of the discrimination needs of the moment. That is, Ss seem to selectively attend to those features which will differentiate an entity as figure against the ground provided by the remainder of the momentary cognitive field. This implies that the total set of attributes which are potentially criterial for making "thing" responses to a particular stimulus pattern are not all used all the time, and that what constitutes concepts like "blue," "swiftly," "tree," "falling" or "subject of" are not unvarying patterns of features but samples from a larger set.

Thus the process of responding to patterns of real-world stimuli as entities may have a character somewhat different from that implied in Lindsay and Lindsay's (1966) idea of "parallel processing"--making judgments along several dimensions simultaneously. The number and identity of the dimensions being processed in parallel may well vary, even though the behavioral outcome is, in all cases, "That is an X." At one point, judgments along dimensions X_a, X_b, X_c, X_d and X_e may be required to identify an instance of X, but at another time (in an environment where there is less probability of X's being present) attributes X_b, X_c and X_g may be actually criterial, and in still other circumstances only X_a may be needed.

Regardless of the number and nature of the attributes being processed, however, it does appear that, in the case of "expected" stimuli, the information associated with several attributes is apparently processed in some kind of "chunking" procedure. For novel stimuli, attribute processing appears to be serial, with a tendency to encode high priority features even when the nature of the assigned task does not call for it.

These considerations and the results of the present experiment may have implications for the concept of linguistic relativity. We appear to attend first to environmental features for which the most accurate verbal descriptions are available. It seems that there is no lack of ability on the part of any normal human being to perceive any attribute of the real world, but encoding preferences may make responding in terms of relatively low codable attribute slower and subject to greater error than would be the case for high codable features. The question arises: Whence come these preferences? It is entirely possible that for a given individual, they emerge through the operations of his language. It seems clear that many ubiquitous real world events (e.g., the diurnal cycle, temperature, birth, walking, the sky, etc.) are encoded in all,

languages. Out of the enormous number of features that can be discriminated in such events, each language tends to select a sample and no two samples may be identical (Carroll, 1958).

It is possible that a given attribute of a universally-familiar event is highly codable in language A, and relatively low in codability in language B. This state of affairs allows differential predictions of the performance of speakers of the two languages in the single and double response tasks used in this experiment. Picture a real world stimulus which is approximately equally familiar to the speakers of both languages, but for the speakers of language A attribute X is high codable and attribute Y, low, while for language B speakers, the codability positions are reversed. Under these circumstances, there should be no differences in the double response times associated with differences in language. However, language A speakers should take longer on the single response tasks calling for identifications of attribute Y, and language B speakers should exhibit more interference in identifying attribute X.

In summary, it appears that discriminably distinct attributes of complex stimuli are differentially codable, and that attributes high in codability are most likely to be used as bases for classifying these stimuli into homogeneous groups. In addition, reporting only a low codable attribute is made more difficult by the concurrent presence of a high codable one. These findings appear to have implications for future studies of codability, recall, problem-solving and linguistic relativity.

Footnote

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References

Berelson, B., Lazarsfeld, P., & McPhee, W. N. *Voting*. Chicago: University of Chicago Press, 1954.

Brown, R. W. *Words and things*. Glencoe, Illinois: The Free Press, 1958.

Brown, R. W., & Lenneberg, E. H. A study of language and cognition. *Journal of Abnormal and Social Psychology*, 1954, *49*, 454-462.

Carroll, J. C. Some psychological effects of language structure. In P. H. Hoch & J. Zubin (Eds.), *Psychopathology of communication*. New York: Grune & Stratton, 1958. Pp. 28-36.

Cofer, C. N. Reasoning as an association process, III. The role of verbal responses in problem solving. *Journal of General Psychology*, 1957, *57*, 55-63.

Glanzer, M., & Clark, W. H. The verbal loop hypothesis: binary numbers. *Journal of Verbal Learning and Verbal Behavior*, 1963, *2*, 301-309.

Glucksberg, S., & Weisberg, R. W. Verbal behavior and problem solving: some effects of labeling in a functional fixedness problem. *Journal of Experimental Psychology*, 1966, *71*, 659-664.

Henle, Mary. On the relation between logic and thinking. *Psychological Review*, 1962, *69*, 366-378.

Jensen, A. R., & Rohwer, W. D. The Stroop Color-Word Test: a review. *Acta Psychologica*, 1966, *25*, 39-93.

Klein, G. S. Semantic power measured through the interference of words with color-naming. *American Journal of Psychology*, 1964, *77*, 576-588.

Koen, F. Codability of complex stimulus: three modes of representation. *Journal of Personality and Social Psychology*, 1966, *3*, 435-441.

Lantz, D., & Stefflre, V. Language and cognition revised. *Journal of Abnormal and Social Psychology*, 1964, *69*, 472-481

Lindsay, R. K., & Lindsay, Jane M. Reaction time and serial versus parallel information processing. *Journal of Experimental Psychology*, 1966, *71*, 294-303.

Morton, J. Categories of interference: verbal mediation and conflict in card sorting. *American Journal of Psychology*, in press.

Underwood, B. J., Ham, M., & Ekstrand, B. Cue selection in paired-associate learning. *Journal of Experimental Psychology*, 1962, *64*, 405-409.

Van de Geer, J. P., & Frijda, N. H. Codability and recognition: an experiment with facial expressions. *Acta psychologica*, 1961, *18*, 360-367.

Table 1

Naming Times in Seconds for Single Response Tasks

Task	Group IA		Group IB		Total Sample	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Ho	21.6	5.8	21.6	3.9	21.6	4.8
Hr	27.6	10.0	30.9	8.0	29.2	8.9
Vo	22.9	2.3	34.4	8.5	28.6	8.5
Vr	41.0	11.6	55.7	13.7	48.3	14.4

Table 2

Naming Times in Seconds for Double Response Tasks

Task Order	Group IA		Group IB	
	Mean	S.D.	Mean	S.D.
First task	H/V(hue then value)		V/H(value then hue)	
	53.6	9.25	67.5	21.35
Second task	V/H(value then hue)		H/V(hue then value)	
	45.6	12.13	55.6	12.12